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Iot Based Smart School Bus Monitoring and Security System

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Abstract - *Having a secured transportation service is not only mandatory to travel agencies but also to educational institutions especially to those having kids under the age of 10 admitted to them. Our proposed system is capable of showing real-time information like the students onboard, location, route, speed, and enables the parents to be notified when their ward boards and alights the bus. We have used GPS and face recognition technologies to connect them to a remote server over WiFi using a Raspberry Pi microcontroller. An Ublox 6M GPS module is used to locate the current geographic coordinates of the bus as well as its speed. The face recognition module identifies each student whenever they board or alight the bus by scanning their image and comparing it with the already trained images which are stored in the cloud. Raspberry Pi takes care of uploading the information from the peripherals. This information can be proctored by the parents as well as the school administration through a mobile application and this helps them track their wards effectively.*

Keywords*: *Raspberry Pi, GPS, Firebase, IoT

I. INTRODUCTION

Notwithstanding to the fact that punctuality is a discipline to be inculcated since the school days, there will be situations where we bound to fail at it. Such is the case with getting on time to board the school bus. In case of the student being in a class below five, it would be mandatory for the parents to pick them up from the school once they descend from the bus. Likewise, having a sound transportation service is inevitable for an educational institution which would aspire to reach even the roots of the country. In order to make all these wishes come true, we have designed a system which would provide the complete status of school students to the school management. Our proposed system tracks the live location, the speed, list of students on the bus with minimal cost. The school management and parents can continuously monitor the bus which will ensure the student's safety while picking up and dropping off.

GPS module continuously tracks the geographical coordinates of the bus and uploads that onto the firebase database through the Wi-Fi available in the microcontroller. This data can be accessed by the parents as well as management through a mobile application that gets the latitude and longitude from the database and plots it on a map. GPS (Global Positioning System) and Google maps are used for navigation and display services respectively. The proposed system notifies the parent when the particular student is recognized by the face recognition module. The microcontroller sends his/her unique ID to the firebase and the notification will be sent to that particular parent. The proposed system also allows parents to notify if their ward is absent from the school so that driver need not wait for the particular student at the stop. The research undertaken by National Highway Traffic Safety Administration in the USA notes that when comparing the number of fatalities of children aged 5 to 18 years during normal school transportation hours, school buses are 87 times safer than private cars. Headlines like "Girl dies in bus tragedy" from the May 18, 2010 issue of the Peninsula newspaper in Qatar seem to be repeated several times every year in different places of the world. Thus, the proposed system will notify the parents if their children have reached the school safely and continuously monitors the school bus.

II. MODULES USED

A. Raspberry pi 3B+

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad-core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi is booted with a micro sd card. The system is using the RASPBIAN operating system which is a massively popular OS. Python is the main programming language used that has a lot of in-built libraries.

B. GPS

GPS is used to determine the geographical position of an object where each GPS satellite broadcasts a message that includes the satellite's current position, orbit, and exact time. A GPS receiver combines the broadcasts from multiple satellites to calculate its exact position using a process called triangulation. Here we have used Ublox 6M GPS which continuously monitors the bus by sending various parameters to the cloud via a Raspberry Pi microcontroller.

C. MPU9250 Axis Accelerometer

MPU9250 9-Axis Accelerometer module is a multi-chip module that combines a 3-axis accelerometer, gyroscope,

and magnetometer, and a Digital Motion Processor (DMP) capable of processing the complex MotionFusion algorithms.

D. Eye Blink Sensor

This sensor is based on IR. It consists of an IR transmitter and IR receiver. It illuminates the eye with infrared light and monitors the changes in the reflected light. The infrared light reflected from the eye is used to determine the results.

E. MQ-2 Smoke Sensor

It is a Metal Oxide Semiconductor (MOS) type gas sensor also known as Chemiresistors as the detection is based upon a change of resistance of the sensing material when the gas comes in contact with the material. Using a simple voltage divider network, the concentration of the gas can be detected.

F. MQ-3 Alcohol Sensor

It is also a Metal Oxide Semiconductor (MOS) type of gas sensor. It detects the attentiveness of the alcohol gas in the air and provides analog voltage as the output. The sensor can activate at a temperature ranging from -10 to 50°C with a power supply of 5V. The sensing range is from 0.04 mg/L to 4 mg/L.

III. SOFTWARE SPECIFICATIONS

In this prototype, the front end of the android application is done using React Native. React Native combines the best parts of native developments with React, a best-in-class JavaScript library for building user interfaces. The backend database and authentication are implemented using Firebase Realtime Database and Firebase Authentication respectively. The hardware functionality was done using Python and the IDE used was Thonny IDE.

IV. PROPOSED SYSTEM DESIGN

The functionalities of the proposed system include the students on board, the speed, the location, and displaying the map in the user interface of the android application which serves the administrator, drivers, and parents to monitor the bus. Figure 1 shows the overall block diagram of the system.

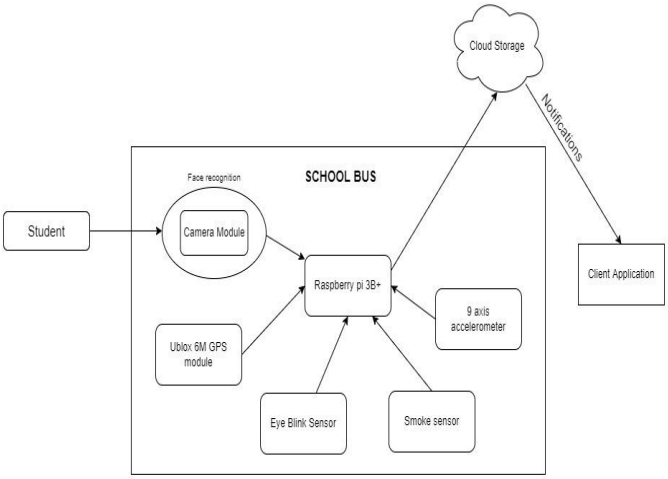

Figure 1. Block Diagram of the proposed system

The student's information such as the register number, parents' contact details, and other details are taken at the time of admission and stored in the database. The camera module is placed at the entrance of the bus. The student can board the bus only if his/her face is recognized. Once the face has been recognized and the student has boarded the bus, his/her parents will be notified that the student has boarded the bus. LCD placed at the entrance will display if the face is recognized or not.

The raspberry pi continuously reads the geographic coordinates of the bus as well as the speed at which the bus is moving. The controller will send these data to firebase through Wi-Fi. It is assumed that the bus has a Wi-Fi adapter that provides Wi-Fi connectivity. Figure 2 depicts the flowchart for the face recognition.

The eye blink sensor that is fitted with the glass senses the eye blink using infrared. As long as the eye is open, the output will be high. Once the eye is closed the output will be low and now the buzzer connected with the Pi buzzes which indicates the drowsiness of the driver.

9 axis accelerometers used here will detect the sudden change in the position of the bus. Whenever the accident occurs there will be a change in the x, endures y, and z-axis output pins which are connected to the controller. So, whenever an accident is detected administrator, and parents will be notified. The alcohol sensor is used to detect ethanol in the air. When a drunk person breathes near the sensor, it detects the ethanol in breathing and provides an output value based on the concentration. Thus, if the driver is drunk then the sensor will detect that and the administrator will be notified and the driver can no longer start the bus. The smoke sensor placed in the bus senses the presence of smoke as a key indication of fire and raises an alarm as well as notifies the administrator.

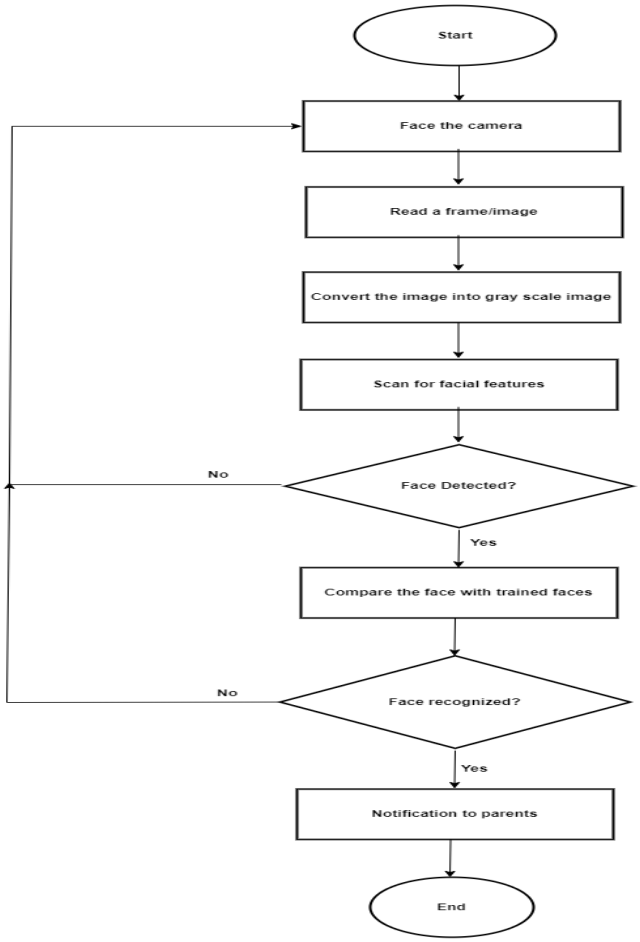

Figure 2. Flowchart for face recognition

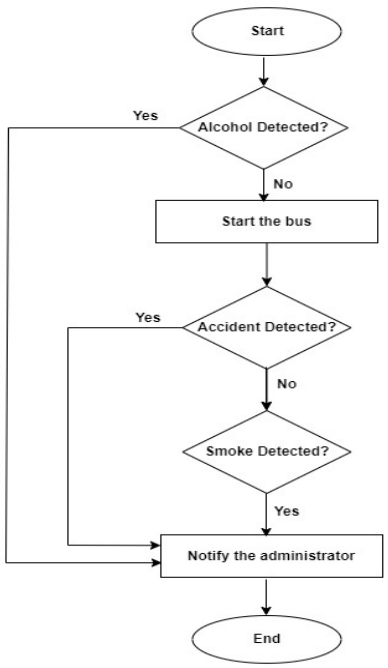

Figure 3. Flowchart for the sensing units

V. USER INTERFACES

The android application has separate logins available for administration, parent, and driver. All three users will be directed to Google Maps once the login is done.

Figure 4. Home page

A. Administrator login

We have three sections inside this login:

i) Create parent, driver account

ii) Add bus

iii) Sensors unit

Add driver option is used to add new driver details to the database and will assign a bus to that driver. Add bus option is used to add new buses if bought by the school administration and this will be updated in the database.

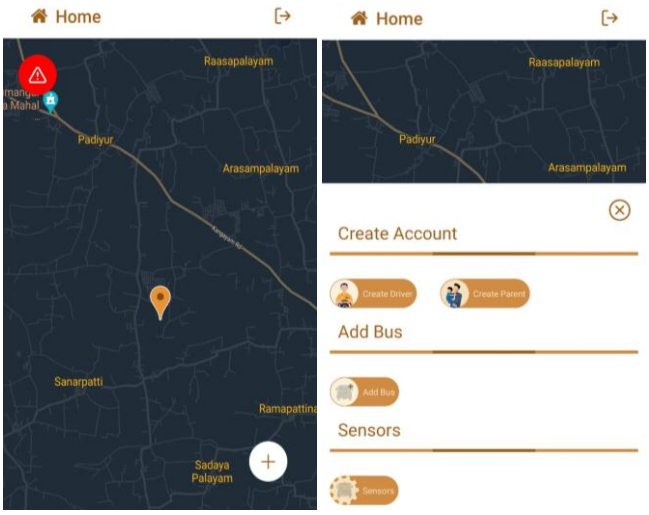

Figure 5. Admin home page

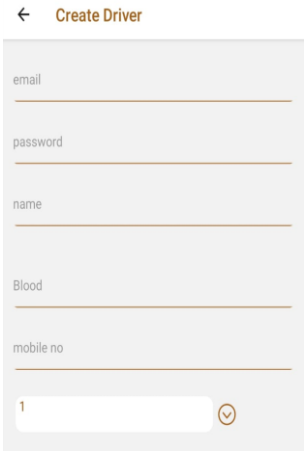

Figure 6. Create driver page

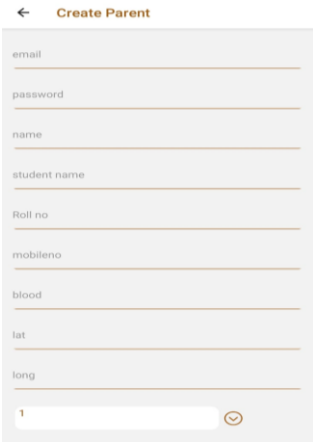

Figure 7. Create parent page

Add parent option is used to create a new parent account and will allow a bus to that student.

Figure 8.Sensors unit

B. Parent login

Once the parent login is done, he/she will be directed to the Google map and can track the school bus. Notify option at the bottom is used to notify the driver that his/her child will not board the bus for that particular day.

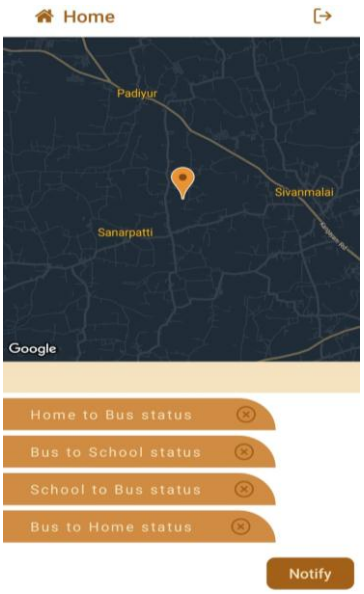

Figure 9. Parent login home page

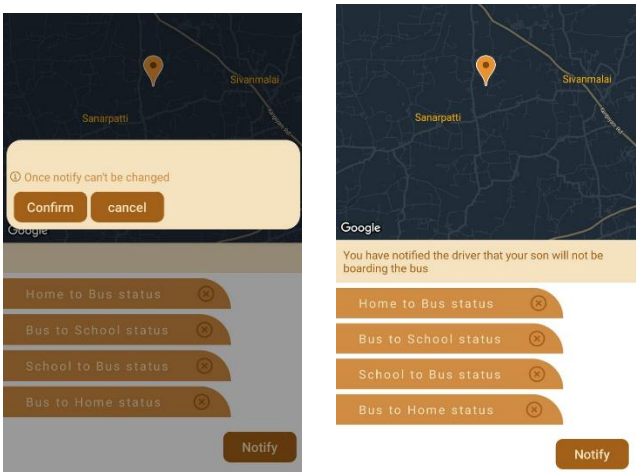

Figure 10.Parent notifying the driver

C. Driver login

Once the login is done, the driver will also be directed to the Google map, and at the bottom, he will find the information about the student who had notified him about his absence. The driver can change the mode of travel such as home-to-bus, bus-to-school, school-bus, and bus-home. These four modes indicate that a student has to scan his/her face four times a day. When a student boards the bus in the morning, the driver sets the mode as home-to-bus. When the bus reaches the school the driver sets the mode as bus-to-school. The student will can his/her face and the parents will be notified that the student has reached the school safely. Once the school is over and when the students board the bus on the return trip the mode will be set as school-to-bus. The parents will be notified that the student has boarded the bus for the return trip. As the bus moves out of the school, the mode will be set as bus-to-home, and when the student alights the bus, the parents will be notified.

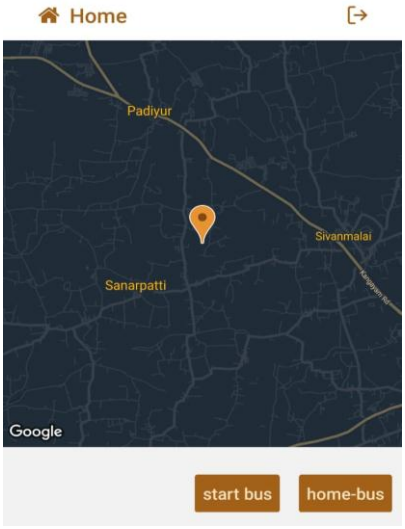

Figure 11. Driver login home page

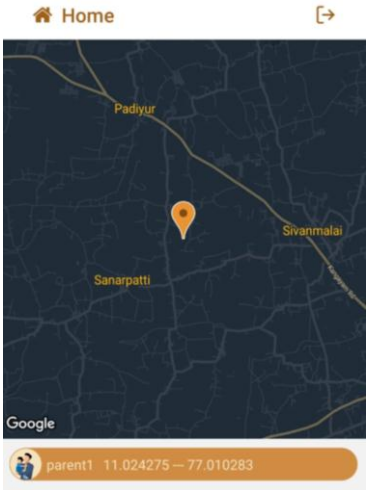

Figure 12. Driver receiving the notification from parents

VI. CONCLUSION

Using this system, the parents can easily track the school bus and ensure that it is moving on the desired route at a safe speed. The drivers can contact the administrator in case of any emergencies This smart school bus application is a user-friendly application that helps parents to track the bus and management monitor the drivers. The parents notifying them about their children's absence the driver will avoid drivers from waiting for that particular student at the bus stop. So, by this system working parents can concentrate on their work after knowing that their child has reached the school safely.

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BIOGRAPHIES

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